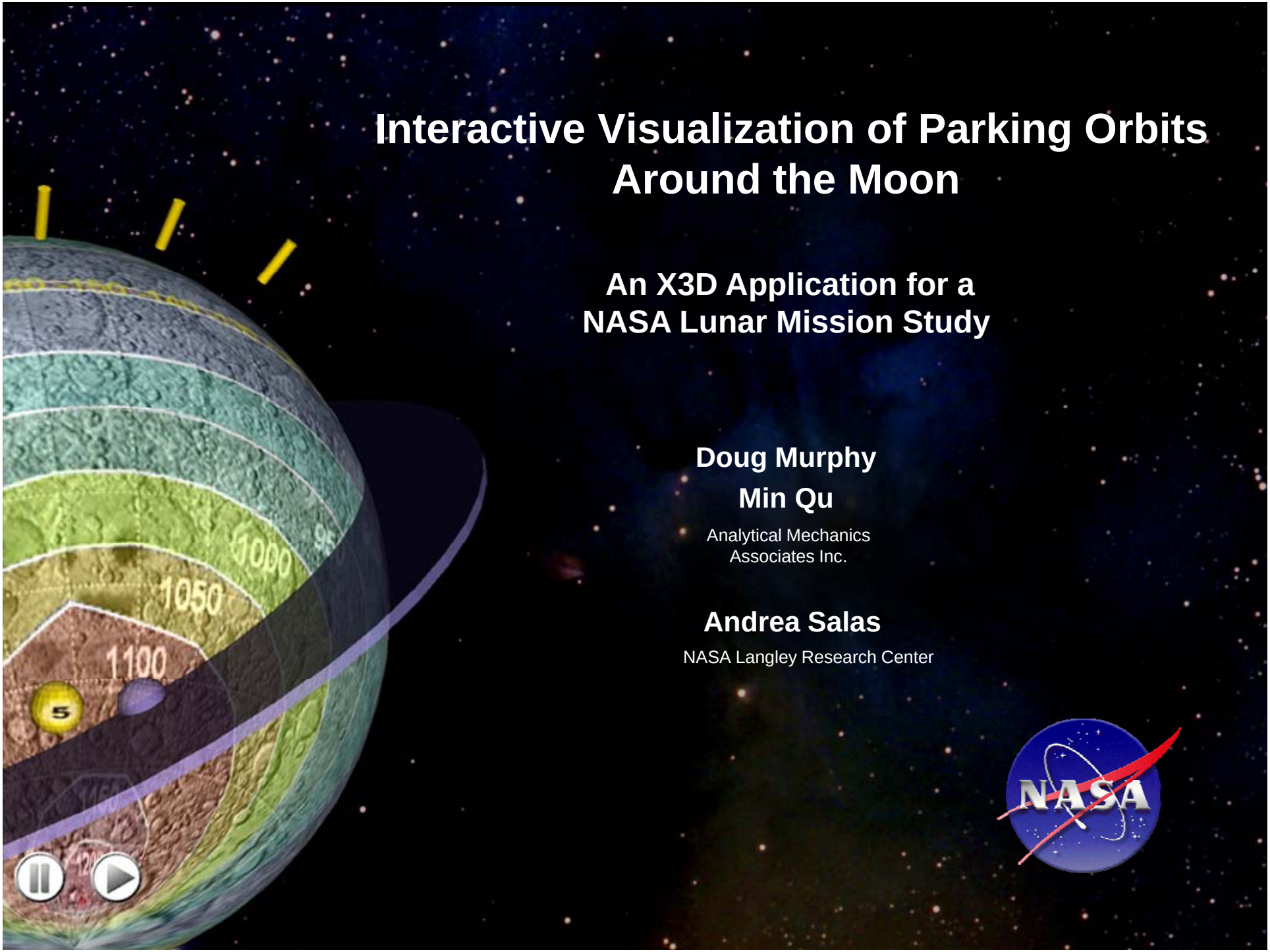

Interactive Visualization of Parking Orbits Around the Moon

An X3D Application for a NASA Lunar Mission Study

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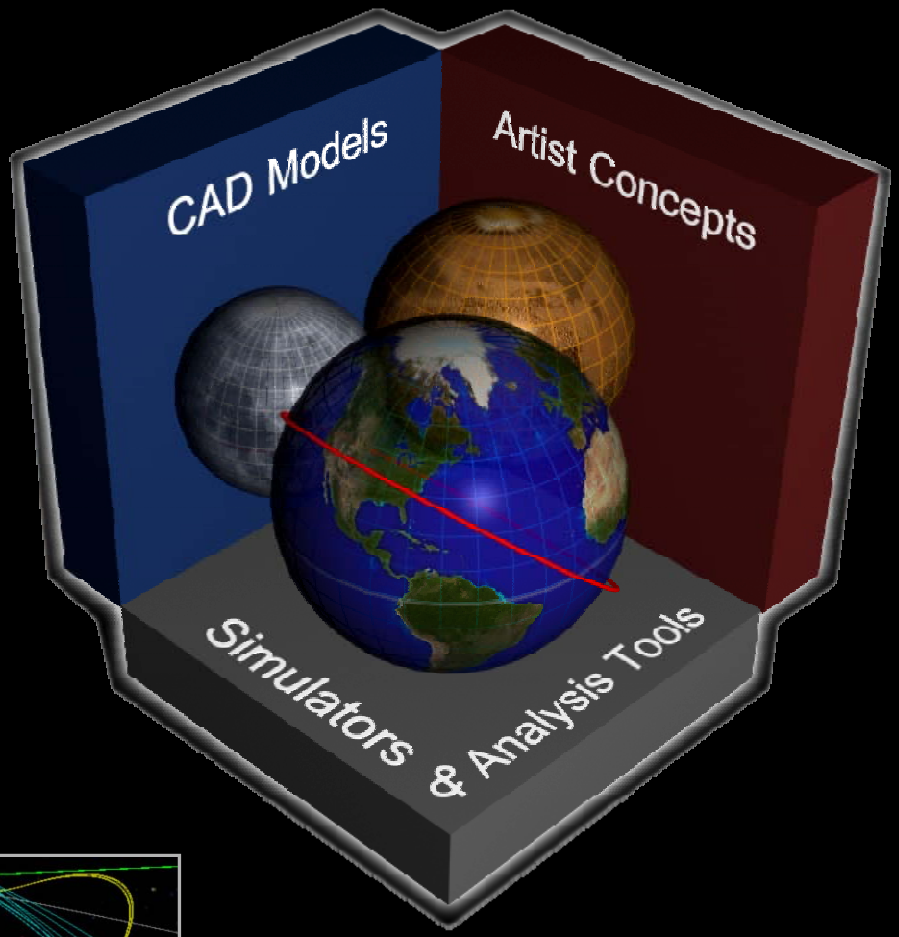
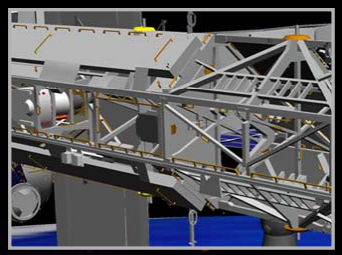
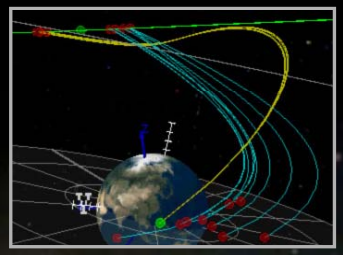
Background: Visualization for Integrated Modeling and Simulation (IM&S)

- IM&S supports the Vision for Space Exploration
- Plans for IM&S include development of a strategic analysis environment and a distributed simulation infrastructure for all levels of analysis
- Interactive visualization will play a key role by providing insight into complex data sets
- Data sources are varied – napkin sketches to flight systems
- Lightweight, 3D web applications provide flexibility - they can be rapidly developed, easily deployed, widely accessed and targeted for a specific need
- X3D enables connectivity between vis tools and analysis & simulation results





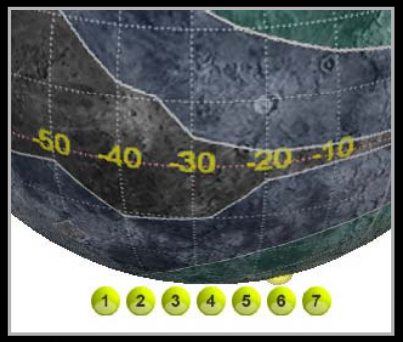


The Challenge: Visualizing the Lunar Parking Orbit for a Strategic Study

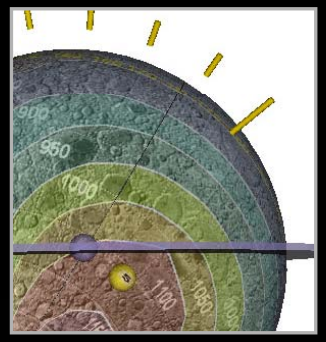
- Our Langley Research Center study team was tasked with examining the system requirements that have the most significant impact on the mission
- The choice of landing site and surface stay have substantial effect on the design of the spacecraft, particularly the propulsion system
- This study required:
  - Global Access
  - 0 to 7 day surface stay
  - Anytime return
- Specifically:
  - “The ascending node and inclination of the lunar parking orbit are selected such that the maximum plane change is minimized for anytime ascent over the 7-day mission.”
- Calculating the required orbit and producing visuals to gain insight into the results was the goal of this short project
- The longer term goal of our team is to build a toolbox of web 3D application parts that can be rapidly assembled for a specific need, and tied to analysis and simulation results via the web (e.g. XML messaging)

The Solution: Interactive Web 3D

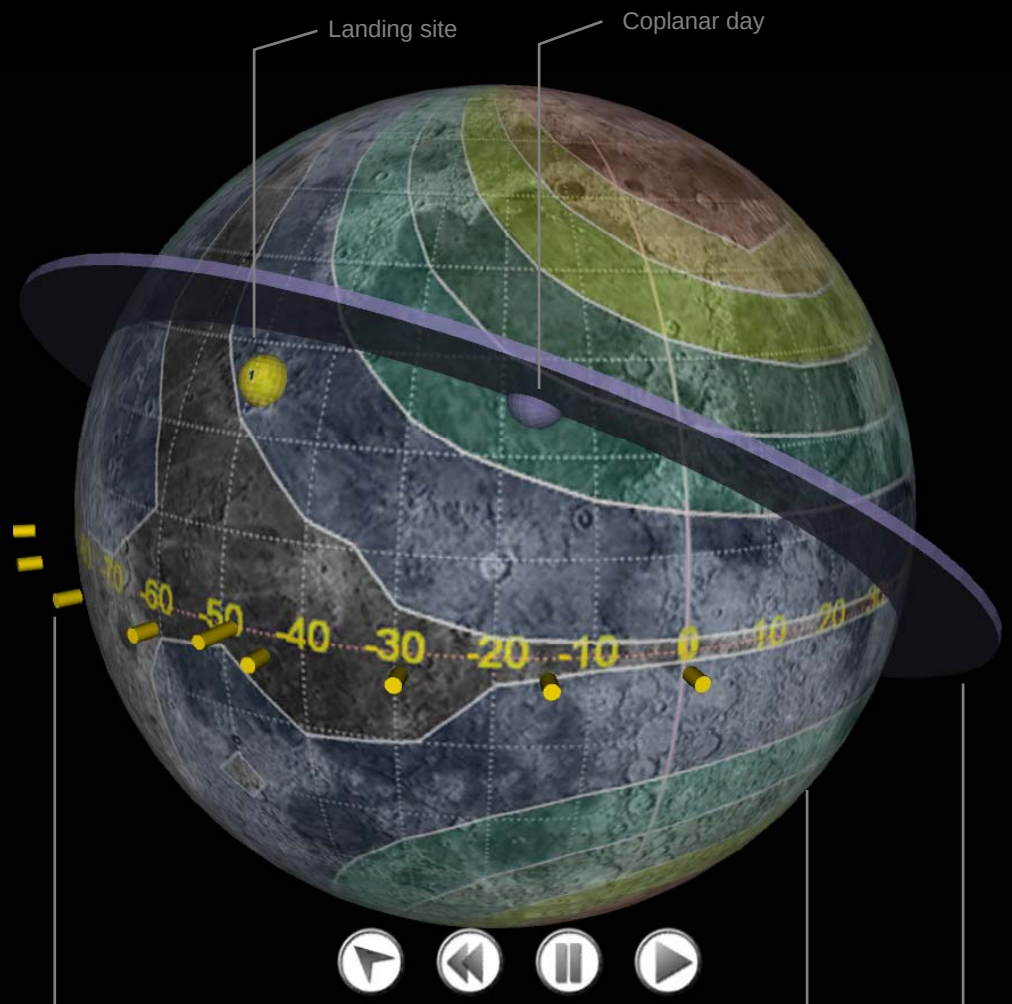
- A Web-based X3D application was deployed within the lunar study team
- X3D browser plug-ins enable the user to see the application embedded in an web page annotated with data specific to each scene
- Straightforward UI elements eliminate learning curve



Map scene links to a different world for each landing site

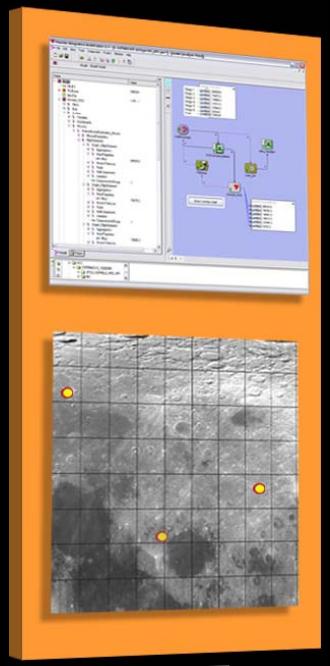


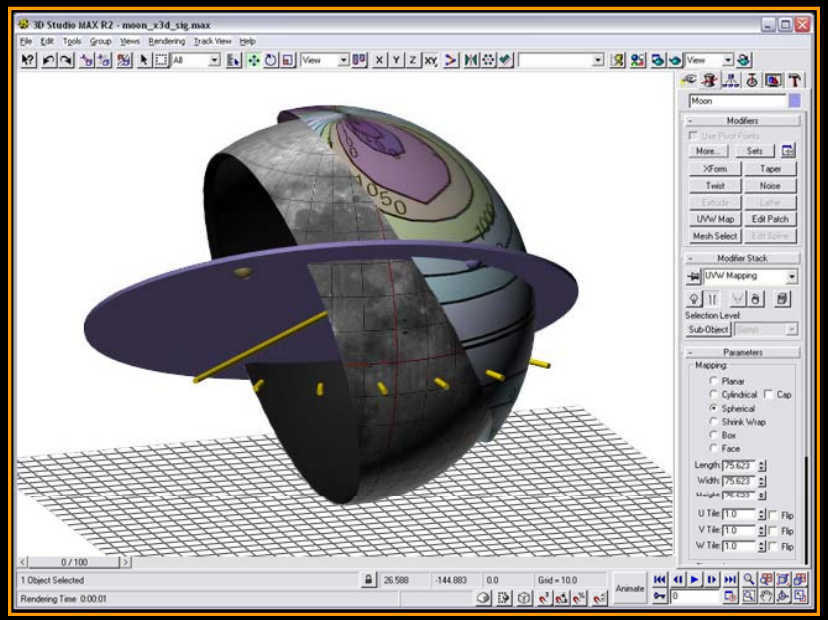
Stored views look at the orbit edge-on



The Construction: Analysis Data and Modeling Tools

- Analytical model created in Phoenix ModelCenter produces orbit plane orientation for each lunar landing site.
- Energy contour maps available from a previous NASA study and moon maps available from JPL are merged to provide globe texture
- Geometric models created in 3D Studio Max, exported and converted to X3D





ModelCenter model produces optimal orbit plane inclination and ascending node

Textured spheres and other primitives created in 3D Studio Max, positioned and oriented according to analysis results, and exported and converted to X3D.

NASA's *Exploration Systems Architecture Study* provides contour map of energy requirements for all points on the lunar globe

Next Steps: Towards a Strategic Analysis Environment

- IM&S is examining the use of HLA and XML messaging for communication among federates in a distributed simulation
- Automating the creation of scenes using analysis data is one of our goals. The X3D Scene Access Interface will be leveraged to enable tools within the strategic analysis environment to communicate with on-line visualizations.